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DO WE REQUIRE TO USE ANTIBACTERIAL PROPHYLAXIS IN HAND TRAUMA? RESULTS OF A RANDOMISED PROSPECTIVE CASE-CONTROL TRIAL

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The proper management of traumatic hand injury is crucial for wound infection prevention. Antibiotics in various forms and conditions are prescribed to avoid this complication, but the effectiveness is unclear. Most forms used are intravenous solutions, topical ointments, and oral tablets. This prospective case-control trial was conducted in a tertiary care hospital. Healthy adult patients with simple, non-bite, surgically treated hand wounds were included. During the surgery, a proper debridement and irrigation with simple saline was consistently performed. Patients were randomly assigned to one of the eight groups. Seven groups received different antibacterial prophylaxis and one received none. At the two-week postoperative follow-up the wound site was assessed and any local infection was documented. Patients were excluded from the trial if they did not comply to treatment recommendations (i.e. commence antibiotics, applied solutions or ointments on the wound). Overall, 240 patients (80.2% male, mean age 38.7 years), 30 in each study group were included. 226 patients returned for the follow-up, and seven patients were excluded from the trial. Wound infection was observed in five patients from different groups. Thus, the rate of wound infection was 2.28%. A Chi-square test revealed no difference in infection incidence between the groups ($p > 0.05$). In this study, antibiotics did not affect incidence of wound infection after hand trauma. Attention should be paid to proper debridement and irrigation of the wound as these interventions reduce the risk for wound infection and avoid unnecessary usage of antibiotics.

Key words: *hand trauma, antibiotics prophylaxis, surgical site infection.*

INTRODUCTION

The hand is the most common injured part of the human body, as trauma mechanisms varies from closed fractures to various kinds of cut and crush wounds (Leaper, 2006). Patients with open cut or crush wounds typically require surgical treatment, and consequently approximately 2000 hand trauma patients annually are referred to the Department of Plastic and Hand Surgery (Microsurgery Centre) at Rīga East Clinical University Hospital "Gaiļezers". Most of these patients have minor trauma and are discharged on the first postoperative day. Every emergency department throughout the country must treat patients with hand trauma. Besides restoring functionality and aesthetics, a main concern is the prevention of surgical site infection (SSI). Antibiotics in various forms are used as prophylaxis, despite the lack of clear evidence for hand trauma and there is no clear standardised practice (Wedmore *et al*., 2005). Prescribing antibiotics increases healthcare costs and antibacterial agents also have a certain possible side effects (Davey *et al*., 2017). Several studies showed the effectiveness for ointments such as mupirocin and fusidic acid in preventing wound infection and improving wound healing (Heggers *et al*. 1995; Gisby and Bryant, 2000; Lio and Kaye, 2009). Mupirocin (Bactroban) ointment is well established decolonisation strategy to eliminate methicillin-resistant *Staphylococcus aureus* (MRSA). Up to 80% of bacteria are resistant to mupirocin (Poovelikunnel *et al*., 2015) Bacterial resistance against an-

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
– The wound is localised in the hands I–V flexor or I–VII extensor zones – The injury is acquired no later than 24 hours prior to the surgery – No more than three anatomical structures are damaged	– The wound is an animal or human bite – Signs of infection are recorded at admission (inflammation, discharge) – The patient took antibiotics contrary to given recommendations – The patient did not follow wound care protocols (inadequate dressing changes, topical solution application) – The patient has a chronic disease such as diabetes, oncology, chronic infections (hepatitis, HIV), and psychiatric disorders. – The patient regularly uses any prescription medication.

tibacterial agents is a growing concern worldwide, and therefore, unnecessary, prolonged and inadequate prescription of antibiotics should be avoided (Harbarth *et al*. 2000). This study was conducted to establish if antibacterial prophylaxis is mandatory for healthy patients with minor and trauma. Based on the current literature and authors' experience it was suggested that the prescription of antibiotics (intravenous, perioral or topical) does not lower the incidence of the SSI in patients with hand trauma.

PATIENTS AND METHODS

This prospective case-control trial was conducted in the Microsurgery Centre. Patients with simple, non-bite wounds in the hand were included in the study, according to the inclusion criteria (Table 1). Topographically, patients with wounds in I–V flexor zones and/or I–VII extensor zones were included (Figs. 1, 2). The authors defined a simple wound as up to three damaged anatomical structures, which included nerves, arteries, tendons, ligaments, joint capsules, and bones (Fig. 3). Patients with chronic diseases or mutilating and/or bite injuries were excluded from this study (Fig. 4). All patients were treated surgically with mandatory debridement and wound irrigation with normal saline solution. Prior to the surgery, patients were randomly assigned to one of eight study groups for prescribed antibacterial prophylaxis (Table 2). Each group received a different antibiotics combination, which included a variation of preoperative intravenous (i/v) first-generation cephalosporin (cephazolin 2 gram solution 40–60 minutes before surgery), postoperative oral (p/o) third-generation penicillin tablets (amoxicillin/clavulanic acid 875/125 milligram one tablet twice a day) for seven days, and local fusidic acid 2% 1 gram ointment applied with postoperative dressings. For penicillin group allergy patients, fluoroquinolones were prescribed (ciprofloxacin 400 mg solution preoperatively and/or 500 mg one tablet twice a day). Group No. 1 did not receive any antibacterial prophylaxis. Group No. 2 received the cephazolin 2 gram solution 40–60 minutes before surgery. Group No. 3 received local fusidic acid 2% ointment. Group No. 4 received the amoxicillin/clavulanic acid 875/125 milligram regiment. Group No. 5 received the cephazolin 2 gram solution and fusidic acid 2% ointment. Group No. 6 received the postoperative regiment of fusidic acid 2% ointment and amoxicillin/clavulanic acid 875/125 milligram tablets. Group No. 7 received the cephazolin 2 gram solution and amoxicillin/clavulanic acid 875/125 milligram regiment. Group No. 8 received the cephazolin 2 gram solution, fusidic acid 2% ointment and the amoxicillin/clavulanic acid 875/125 milligram regiment. Post-operatively all patients

Fig. 1. Illustrative figure. Patient does not meet inclusion criteria (author's photo). A healthy 52 year old male with a crushed hand injury and multiple digit amputation. As the soft tissue damage is extensive, the patient required multiple surgeries, and therefore, antibacterial prophylaxis is indicated.

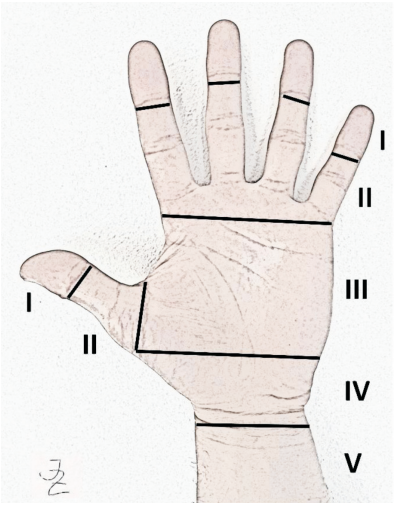

Fig. 2. Illustrative figure. Hand flexor zones. Patients with wounds in I–V zones were included. Zone I is distal to the superficial digital flexor or long thumb flexor insertion. Zone II borders are from the superficial digital flexor or flexor *pollicis longus* insertion to the A1 pulley. Zone III consists from the A1 pulley to the distal border of the carpal tunnel. Zone IV comprises of the carpal tunnel. Zone V represents the distal part of the tendomuscular junction.

Table 2. Study groups and results. Representing outcome, incidence and statistical evaluation

	Cephazolin 2 gram solution 40–60 minutes preoperatively	Fusidic acid 2% (20 mg/g) 1 gram ointment topical with wound dressings	Amoxicillin/Clavulanic acid 875/125 milligram tablet twice a day for seven days postoperatively	No. of SSI	Incidence, %	*p* value
Group No. 1				1	3.33	0.52
Group No. 2	Received			1	3.57	0.50
Group No. 3		Received		0	0	0.47
Group No. 4			Received	1	3.70	0.49
Group No. 5	Received	Received		0	0	0.58
Group No. 6		Received	Received	1	3.33	0.53
Group No. 7	Received		Received	0	0	0.60
Group No. 8	Received	Received	Received	1	3.33	0.53

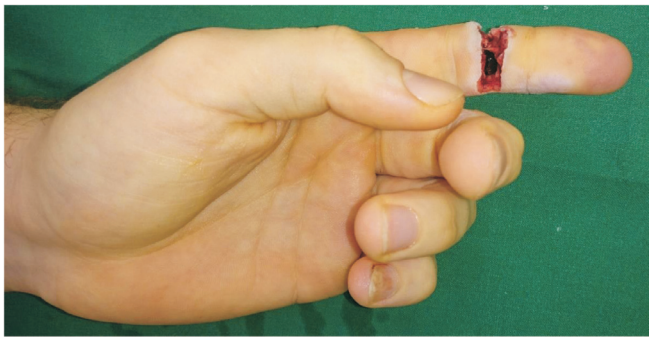

Fig. 3. Illustrative photo. Typical study participant met inclusion criteria (author's photo). A healthy 30 year old male, who injured his non-dominant left hand with an angle grinder. The result included a damaged deep flexor tendon and digital nerve. Trauma-to-surgery time was eight hours.

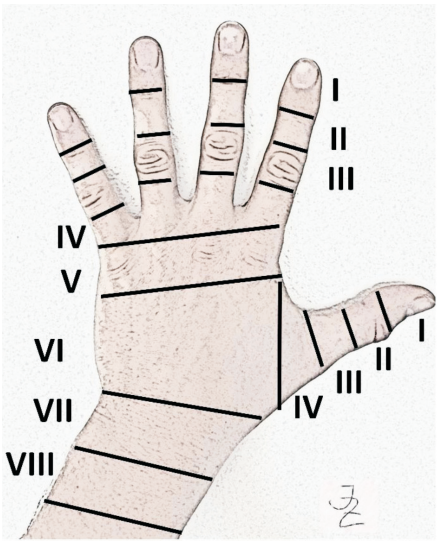

Fig. 4. Illustrative figure. Hand extensor zones. Patients with wounds in I–VII zones were included. Zone I is distal to the digital distal interphalangeal joint and the thumb's interphalangeal joint. Zone II comprises the middle phalanx region and the thumb's proximal phalanx. Zone III presides over the digital proximal interphalangeal joints and the thumb's metacarpal joint. Zone IV comprises the digital proximal phalanx and the thumb's metacarpal bone. Zone V consists of the digital metacarpophalangeal joints and the thumb's carpometacarpal joint. Zone VI spans over the digital metacarpal bones. Zone VII encompasses the wrist joint. For the thumb: zone I localised distally to the interphalangeal; joint. Zone II projects at the level of proximal phalanx and zone III localised at the level of metacarpophalangeal joint.

had to follow the same wound care protocol: clean cotton dressing changed every three days; no additional solutions or ointments used during wound healing; skin sutures removed 12 to 14 days post-operatively. During wound care, paraffin gauze dressing without any other additives was used during wound healing. Follow-up was completed after two weeks. The Bluebelle Wound Healing Questionnaire was used to evaluate wound healing and signs of SSI (Anonymous, 2019). Patients were asked the following regarding their wound healing experience: was there increased redness around the wound, was the skin around the wound warmer than other areas, was there swelling around the wound, was there increased pain around the wound, was there any discharge from the wound, and was there any unusual smell from the wound. Lastly, the patients were asked whether the skin sutures were removed on time. If any of these questions were answered positively, the patient was invited to a surgeon's consultation to assess the wound. Patients were excluded from the trial if they did not follow the wound care protocol and/or started using any additional treatments outside the study's perimeters.

Ethical permission was granted by the Research Ethics Committee of Rīga Stradiņš University (Decision No. 20/08.09.2016). Every patient signed an informed consent upon admission to the study.

Statistical analyses were performed using IBM SPSS version 23.0. Incidence of the SSI in every group was calculated. Statistical difference between groups was evaluated with chi-square and Mann–Whitney U tests.

RESULTS

During the two years of this study, 240 patients were included in the trial, 30 patients in every group. The patient mean age was 38.7 years (range 14–78 years), and 80.2% of participants (n = 192) were male while 19.8% (n = 48) were female. Post-operatively, 225 patients (93.75%) returned for the follow-up. A total of nine patients were excluded from the study. Six patients were prescribed antibiotics by their general practitioner contrary to our recommendations. One patient started antibacterial therapy due to pneumonia. Two

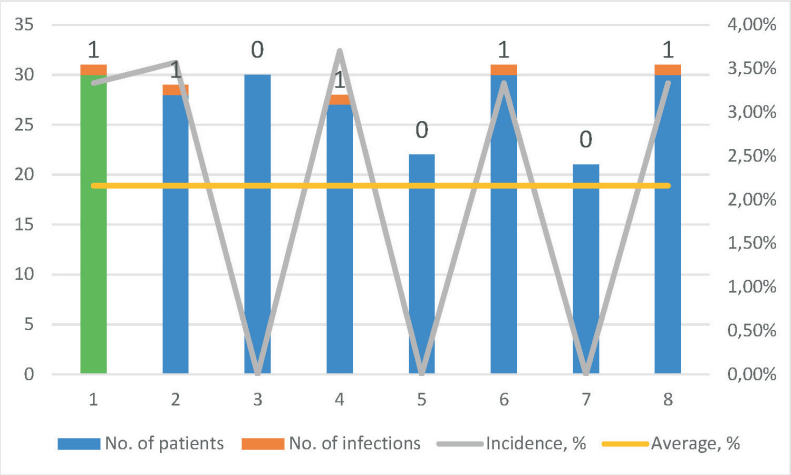

Fig. 5. Level of infections and incidence in groups with different antibiotics treatment. Group No. 1 did not receive any antibacterial prophylaxis (data plot marked green). Group No. 2 received the cephazolin 2-gram solution 40–60 minutes before surgery. Group No. 3 received local fusidic acid 2% ointment. Group No. 4 received the amoxicillin/clavulanic acid 875/125 milligram regiment. Group No. 5 received the cephazolin 2-gram solution and fusidic acid 2% ointment. Group No. 6 received the post-operative regiment of fusidic acid 2% ointment and amoxicillin/clavulanic acid 875/125 milligram tablets. Group No. 7 received the cephazolin 2-gram solution and amoxicillin/clavulanic acid 875/125 milligram regiment. Group No. 8 received the cephazolin 2-gram solution, fusidic acid 2% ointment and the amoxicillin/clavulanic acid 875/125 milligram regiment.

Table 3. Statistical analyses of the results using IBM SPSS version 23.0.

	Value	df	Exact Sig. (two-sided)
Chi-square	0.168	7	0.682
Likelihood ratio	0.151	7	0.698
Linear-by-Linear Association	0.167	7	0.683
Mann–Whitney U	2786.000	7	0.683

patients did not follow the wound care protocol. Five cases of the SSI were documented, and each patient was from a different group (Table 2). Overall SSI incidence was 2.16% (Fig. 5). Chi-square and Mann–Whitney U tests showed no difference between SSI incidence amongst groups (95% Cl, $p > 0.05$) (Table 3).

DISCUSSION

This study was performed with the hypothesis that antibiotic prophylaxis does not reduce the incidence of the SSI in patients with simple hand lacerations. Although in our study patients had complex injuries such as severed tendons, digital nerves and arteries, and some had open fractures, the injuries followed the inclusion criteria. The results revealed that SSI rates were low even in these patients, as long as risk factors for the SSI were considered. In multiple studies, the main risk factors for the SSI are delayed treatment time (trauma to hospital admission), extensive crush damage, and the patient's overall health status (Hollander *et al*., 2001; Zehtabchi *et al*., 2012; Quinn *et al*., 2013; Roodsari *et al*., 2015). The importance of proper wound debridement and irrigation of traumatic wound has been acknowledged for quite some time, and should be emphasised and not neglected in treatment protocols (Cassell and Ion, 1997; Lee and Di Mascio, 2014). The amount and aggressiveness of debridement is negotiable. However, the Microsurgery Centre practices in accordance with literature recommendations that debridement must include evacuation of any foreign bodies (metal, plastic particulates, dirt, etc.) and excision of devitalised tissues (Lumbers, 2018). The results of this study compared with similar studies revealed lower SSI rates — 2.28% versus 5.6% in a meta-analysis of 13 studies (Murphy *et al*. 2016). As in other studies, SSI rates do not significantly differ if patients do or do not receive antibiotics. While taking into consideration the risk factors, this study proved that antibiotics are not necessary for patients with traumatic hand wounds, which reflects the results of other studies (Zehtabchi *et al*. 2012; Murphy *et al*. 2016). Despite these studies not justifying antibiotics for most hand injuries, antibiotics are still widely prescribed for patients with hand injuries (Johnson *et al*. 2018). The lack of clear national and international guidelines may be the main reason. There are concerns regarding unnecessary prescription of the antibiotics that equate to increased bacterial resistance; however, physicians can decrease and prevent bacterial resistance with careful evaluation of the necessity for antibiotics and avoiding unnecessary prescription.

CONCLUSIONS

Results of this study confirmed the authors` hypothesis that antibiotic prophylaxis do not reduce the incidence of hand wound infections. With one case of the SSI of 30 patients (3.3%) in the control group with no antibiotics versus four cases of the SSI of 184 patients (2.1%) amongst study groups, statistical analysis showed no difference of incidence of SSI between all groups. Also, no evidence was found that some antibacterial regiment is superior compared with others. Initial evaluation of each patient's overall health status and severity of hand injury is crucial for determining the necessity of antibacterial treatment. By taking into consideration the patient's local and general risk factors for SSI, most patients can be treated without any antibiotics. The crucial aspect of hand injury treatment is proper debridement and irrigation of the wound. Limitations of this study include a relatively small number of patients who did not receive any antibiotics. This study shall be continued to obtain even more statistically significant data.

CONFLICT OF INTERESTS

The authors declared no potential conflicts of interests with respect to the research, authorship, and/or publication of this article.

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VAI IR NEPIECIEŠAMA ANTIBAKTERIĀLĀ PROFILAKSE PACIENTIEM AR PLAUKSTAS TRAUMĀM? RANDOMIZĒTA PROSPEKTĪVA GRUPU KONTROLĒTA PĒTĪJUMA REZULTĀTI

Jebkurā Latvijas traumpunktā vēršas pacienti ar brūcēm plaukstā. Viena no galvenajām problēmām ir brūces infekcijas risks. Plaši tiek lietotas dažādas antibiotikas dažādās formās, lai gan to efektivitāte nav pierādīta. Nav arī vienotu vadlīniju, kur būtu skaidri noteikts, kādas antibiotikas kādās situācijās ir jālieto. Rīgas Austrumu klīniskās universitātes slimnīcas Rokas un plastiskās ķirurģijas nodaļā, Mikroķirurģijas centrā, tika veikts randomizēts prospektīvs gadījumu kontroles pētījums. Pacientu iekļaušanas kritēriji bija šādi: veseli pieaugušie ar nekomplicētām plaukstas brūcēm (ne vairāk par trim bojātām struktūrām) fleksoru I–V un ekstenzoru I–VII zonās. Izslēgšanas kritēriji bija kostas, dragātas brūces, pirkstu amputācijas, pacienti ar hroniskām saslimšanām. Visi pacienti tika ārstēti ķirurģiski. Obligāta operācijas sastāvdaļa bija bojāto audu rezekcija *(debridement)* un brūces skalošana ar fizioloģisko šķīdumu. Balstoties uz lietotajām antibiotikām, pacienti tika iekļauti vienā no astoņām pētījuma grupām. Tika lietots pirmās paaudzes cefalosporīns intravenozi, trešās paaudzes penicilīns perorāli, lokāli fucidīnskābes ziede. Gadījumā, ja pacientam ir alerģija uz penicilīniem, tika pielietoti fluorhinoloni. 1. grupas pacienti nesaņēma antibiotikas, 2.–4. grupa – vienu antibiotiķi, 5.–7. grupa – divus antibiotiķus, 8. grupa – trīs antibiotiķus. Kontrole tika veikta divas nedēļas pēc operācijas. Tika novērtētas brūces iekaisuma vai infekcijas pazīmes. Pacienti tika izslēgti no pētījuma, ja netika ievērotas pēcoperācijas rekomendācijas. Pētījumā tika iekļauti 240 pacienti (80,2% vīriešu, 19,8% sieviešu, vidējais vecums 38,7 gadi). Katrā grupā tika iekļauti 30 pacient. Pēcoperācijas kontrolei atsaucās 226 pacienti (94% no iekļautiem). No pētījuma tika izslēgti septiņi pacienti. Brūces infekcija attīstījās pieciem pacientiem no dažādām grupām. Infekciju incidence bija 2,28%. Hī-kvadrāta un Manna–Vitneja testi neuzrādīja statistiski ticamu atšķirību starp infekciju incidencēm dažādās grupās ($p > 0,05$). Šajā pētījumā antibiotikas neietekmēja brūču infekciju incidenci pacientiem ar plaukstas traumām. Svarīga ir brūču mehāniska attīrīšana: bojāto audu rezekcija un skalošana *(irrigation)*. Mehāniska brūces attīrīšana ievērojami samazina infekcijas risku un palīdz izvairīties no nevajadzīgas antibakteriālās terapijas lietošanas.